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.. not available for a specific reference period
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0^s value rounded to 0 (zero) where there is a meaningful distinction between true zero and the value that was rounded
^{p} preliminary
^{r} revised
x suppressed to meet the confidentiality requirements of the *Statistics Act*
^{E} use with caution
F too unreliable to be published
* significantly different from reference category ($p < 0.05$)

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Housing conditions and respiratory hospitalizations among First Nations people in Canada

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Abstract

Background: Respiratory diseases are among the leading causes of acute care hospitalization for First Nations people. Poor housing conditions are associated with respiratory disorders and may be related to the likelihood of hospitalization. This analysis examines whether First Nations identity is associated with higher odds of hospitalization for respiratory conditions relative to non-Aboriginal persons, and whether such differences in hospitalization rates remain after consideration of housing conditions.

Data and methods: Data from the 2006 Census linked to the Discharge Abstract Database were used to analyze differences in hospitalization for respiratory tract infections and asthma between First Nations and non-Aboriginal people when housing conditions were taken into account.

Results: Rural on-reserve First Nations people were more likely than non-Aboriginal people to be hospitalized for a respiratory tract infection (1.5% versus 0.5%) or for asthma (0.2% versus 0.1%). For respiratory tract infection hospitalizations, adjustment for housing conditions, household income and residential location reduced differences, but the odds remained nearly three times higher for on-reserve First Nations people (OR = 2.83; CI: 2.69 to 2.99) and two times higher for off-reserve First Nations people (OR = 2.03; CI: 1.87 to 2.21), compared with the non-Aboriginal cohort. For asthma hospitalizations, adjustment for household income reduced the odds more than did adjustment for housing conditions. Even with full adjustment, the odds of asthma hospitalization relative to non-Aboriginal people remained significantly higher for First Nations people.

Interpretation: First Nations people are significantly more likely than non-Aboriginal people to be hospitalized for respiratory tract infections and asthma, even when housing conditions, household income and residential location are taken into account. While housing conditions are associated with such hospitalizations, household income may be more important.

Key words: Aboriginal identity, asthma, crowding, data linkage, dwelling conditions, hospital records, respiratory tract infections

Diseases of the respiratory system are among the leading causes of acute care hospitalization for Aboriginal people in Canada, particularly First Nations people.[1] These hospitalizations contribute to overall differences in acute care hospital use between the First Nations and non-Aboriginal populations,[1-5] a finding consistent with American studies.[6,7]

Poor housing conditions such as crowding,[8] need for major repairs[9,10] and compromised indoor air quality[10-13] have been associated with respiratory conditions,[10,11] especially among Aboriginal populations.[9,14] Specific housing risk factors are related to certain respiratory illnesses. For pneumonia and influenza, crowding has been reported as a risk factor among Aboriginal people.[8,14,15] Other circumstances, including socio-economic disadvantage,[16,17] additional chronic conditions[14] and remote location,[16] have also been identified as key factors.

However, many studies were based on information collected for individual Aboriginal communities or defined geographies. And while poor housing conditions have been documented in First Nations communities,[18] there remains the need to examine the relationship between housing conditions and health among those living on reserves.[17] About 40% of First Nations people in Canada live on Indian reserves and settlements, where housing is more likely to be crowded or need major repairs.[18,19]

Analysis of the relationship between housing conditions and respiratory health must also consider the possible confounding effects of social determinants such as income.[19] For example, a 2011 study found crowding and poor indoor air quality to be associated with tuberculosis in First Nations communities,[14] but the role of income was not examined.

This study examines whether First Nations Aboriginal identity is associated with a greater likelihood of hospitalization for selected respiratory conditions when adjusting not only for housing, but also for location (on or off reserves, urban or rural) and household income. The analyses are based on information from the 2006 Census linked to hospital discharge data from the Discharge Abstract Database (DAD).[20]

Data and methods

Data sources

The 2006 Census (long-form) was linked to the DAD (2006/2007 to 2008/2009) for all jurisdictions except Quebec.

For most of the country, the long-form census questionnaire is completed by about 20% of the household population. The institutionalized population is not included in the linked census-DAD data. The data collected include income, housing and Aboriginal identity. In 2006, the long-form questionnaire was administered to all residents of Indian reserves and many remote and northern communities.[21] However, 22 Indian reserves and Indian settlements were incompletely enumerated, and so are not represented.[22]

The DAD, which is provided annually to Statistics Canada by the Canadian Institute for Health Information, contains demographic, administrative and clinical data on discharges from all acute care hospitals and some psychiatric, chronic rehabilitation

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and day-surgery facilities in all provinces and territories except Quebec.[23]

Approximately 4.7 million census long-form respondents were eligible to link to the DAD for the three fiscal years from 2006/2007 to 2008/2009. Linkage was performed using a hierarchical deterministic approach based on date of birth, sex and postal code. A validation study found the linked file to be suitable for health research and broadly representative of people in Canada, with the limitation that linkage eligibility rates were lower among respondents identifying as Aboriginal.[20] Linkage eligibility for First Nations respondents also varied by whether they lived on or off reserves, and by province or territory. As a result, hospitalizations of Aboriginal people, particularly First Nations people living on reserves, may be underestimated.

The linkage was approved by Statistics Canada's Executive Management Board[24] and is governed by the Directive on Record Linkage.[25] Details of the methodology are available elsewhere.[20]

Statistics Canada ensures respondent privacy during linkage and subsequent use of the linked files. Only employees directly involved in the linkage process have access to the unique identifying information (such as name and sex) and do not access health-related information. When linkage is completed, an analytical file is created from which identifying information has been removed. This de-identified file is accessed by analysts for validation and analysis.

Study sample

The study cohort comprised 4.5 million respondents to the 2006 long-form Census who were eligible for linkage to the DAD. Aboriginal identity was derived from the question: "Is this person an Aboriginal person, that is, North American Indian, Métis or Inuit (Eskimo)?" For this study, First Nations people were defined as those who self-identified only as North American Indian (n = 306,400). Respondents who did not report Aboriginal identity were categorized as non-Aboriginal (n = 4,230,400). The study cohort excludes those who self-identified as Métis or Inuit and those self-identifying with more than one Aboriginal group.

Reserve status of First Nations respondents was based on criteria established by Indigenous and Northern Affairs Canada and was classified using Statistics Canada's standard census geography, the census subdivision. In this cohort, the majority (75%, n = 229,300) of First Nations people were living on reserves (Indian reserves or Indian settlements) at the time of the 2006 Census.

Outcomes

Two types of hospitalization were examined: respiratory tract infection and asthma, identified by the "most responsible diagnosis" in the DAD hospital record. Based on codes in the *International Statistical Classification of Diseases and Related Health Problems—Canada, Tenth Revision* (ICD-10-CA),[26] respiratory tract infections were defined by J09-J18 (influenza and pneumonia) and J20-J22 (other acute lower respiratory tract infections).[27] The codes indicating asthma were J45 and J46.[28] Dichotomous variables were used to indicate if an individual had been hospitalized at least once for the respiratory condition during the 2006/2007 to 2008/2009 period.

Covariates

All covariate information was from the 2006 Census. *Crowded housing* was defined as more than one person per room. The number of people in a household included all usual residents, even if temporarily away. The number of rooms pertained to kitchens, bedrooms, finished rooms in the attic or basement, but not to bathrooms, halls, vestibules and rooms used solely for business. Residents of collective dwellings were excluded from the derivation of crowded dwelling. *Dwelling in need of repair* was based on the question, "Is this dwelling in need of any repairs?" Response categories were: "No, only regular maintenance"; "Yes, minor repairs"; and "Yes, major repairs." Age was grouped as: younger than 20, 20 to 34, 35 to 49, and 50 or older. *Annual household income quintile* was derived at the economic family level or directly for unattached individuals. For each household, total after-tax income from all sources from all members was summed, adjusted for household size, and divided into quintiles. To minimize regional income differences, quintile thresholds were estimated separately for each province/territory, and then pooled.

Differences in access to and use of health care have been noted between rural and urban residents.[29-32] *Urban* areas are the urban core, or the urban fringe in census metropolitan areas (CMA) and census agglomerations (CA), as well as urban areas outside metropolitan areas and secondary urban cores. The latter represent the urban core of a CA that has merged with an adjacent CMA or CA. *Rural* areas are all territories not classified as an urban core or urban fringe, and rural areas outside CMAs/CAs. In 2011, Statistics Canada changed the standards for reporting this concept; researchers using a more recent vintage of data should consult the revised standard.[33] No adjustment was made for mobility during the 2006-to-2008 period.

Statistical methods

Cross-tabulations were used to describe the demographic and socioeconomic characteristics of First Nations and non-Aboriginal people. The odds of each respiratory-related hospitalization outcome were estimated with multivariate logistic regression models. Models used the total study cohort, with First Nations individuals stratified by on- or off-reserve residence. The non-Aboriginal population was the reference group. For each outcome, five sequential models that build upon each other by adding covariates while retaining those from previous steps were estimated, adjusted for: 1) age, sex and province/territory of residence; 2) plus rural or urban residence; 3) plus dwelling needing major repair; 4) plus crowding; and 5) plus household income quintile. Analyses were completed using SAS version 9.3.

Table 1
Selected characteristics of linked study cohort, by rural/urban location, First Nations (on or off reserves) and non-Aboriginal identity groups, household population, Canada excluding Quebec, 2006

	First Nations							Non-Aboriginal		
		On reserves			Off reserves					
Characteristics	Total	Total	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban
Total number (000s)	306.4	229.3	212.5	16.8	77.0	22.8	54.2	4,230.4	822.6	3,407.8
					percentage distribution (%)					
Total	100	100	100	100	100	100	100	100	100	100
Age group										
0 to 9	22	22	22	20	21	21	21	11	11	11
10 to 19	22	22	22	22	21	22	21	13	14	13
20 to 29	14	15	15	14	14	12	15	13	9	13
30 to 39	13	13	13	13	14	13	15	14	12	14
40 to 49	13	12	12	14	14	14	14	17	17	17
50 or older	16	16	15	18	16	18	15	33	37	32
Region										
Atlantic	6	7	6	15	6	11	3	10	23	6
Ontario	20	17	17	19	28	20	31	51	38	55
Manitoba	20	22	24	1	12	11	12	4	6	4
Saskatchewan	18	19	19	19	14	16	13	4	7	3
Alberta	15	15	16	0	16	19	15	14	13	14
British Columbia	17	17	14	47	19	12	21	17	12	18
Territories (Yukon, Northwest Territories, Nunavut[†])	5	4	5	0	6	9	4	0	1	0
Location										
Rural	77	93	...	...	30	...	...	19	...	...
Urban	23	7	...	...	70	...	...	81	...	...
Housing conditions										
Needs major repairs	40	47	47	43	19	27	15	7	9	6
Crowded	22	26	26	21	9	15	6	3	2	3
Household income quintile										
Lowest	49	53	43	39	36	23	28	17	11	9
At least one hospitalization for:										
Respiratory tract infection[‡]	1.3	1.5	1.5	1.0	1.5	1.1	0.6	0.4	0.5	0.3
Asthma[§]	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1

... not applicable

† no reserves were located in Nunavut in 2006

‡ ICD-10-CA codes J09-J18 (pneumonia, influenza), J20-J22 (other acute lower respiratory tract infections)

§ ICD-10-CA codes J45-J46

Sources: 2006 Census linked to Discharge Abstract Database (2006/2007 through 2008/2009).

Table 2
Adjusted odds ratios relating First Nations identity to at least one hospitalization for respiratory tract infection or asthma, by residence on or off reserves, household population, Canada excluding Quebec, 2006/2007 through 2008/2009

	Respiratory tract infection						Asthma					
	On reserves			Off reserves			On reserves			Off reserves		
	Odds ratio	95% confidence interval		Odds ratio	95% confidence interval		Odds ratio	95% confidence interval		Odds ratio	95% confidence interval	
		from	to		from	to		from	to		from	to
Unadjusted	3.85*	3.71	3.99	2.03*	1.87	2.20	2.13*	1.92	2.35	2.30*	1.96	2.70
Adjusted for:												
Age, sex and province/territory	4.09*	3.93	4.27	2.34*	2.15	2.54	1.58*	1.42	1.76	1.80*	1.53	2.12
Plus rural/urban	3.46*	3.30	3.63	2.30*	2.11	2.50	1.60*	1.42	1.80	1.80*	1.53	2.12
Plus dwelling needing major repairs	3.35*	3.19	3.52	2.27*	2.09	2.47	1.51*	1.33	1.71	1.76*	1.49	2.07
Plus crowding	3.25*	3.09	3.43	2.27*	2.09	2.47	1.52*	1.33	1.73	1.76*	1.49	2.08
Plus household income quintile	2.83*	2.69	2.99	2.03*	1.87	2.21	1.33*	1.16	1.51	1.57*	1.33	1.86

* significantly different from non-Aboriginal population ($p < 0.05$)

Note: Reference category is non-Aboriginal population.

Sources: 2006 Census linked to Discharge Abstract Database (2006/2007 through 2008/2009).

Results

Demographic and socioeconomic characteristics

First Nations people were relatively young and were more likely than non-Aboriginal people to live in Manitoba, Saskatchewan or the Territories, and in rural areas (Table 1). An estimated 40% of First Nations people were in dwellings that needed major repairs, and 22% lived in crowded conditions; the comparable figures for non-Aboriginal people were 7% and 3%. Half of First Nations people were in households in the lowest income quintile, compared with 17% of the non-Aboriginal population. These findings were consistent across reserve status (on/off reserves) and geographic location (rural versus urban).

Respiratory-related hospitalizations

The prevalence of at least one respiratory-related acute care hospitalization during the 2006/2007 to 2008/2009 period was higher for First Nations people, particularly those living on reserves, than for non-Aboriginal people (Table 1).

Among those in rural areas, First Nations people living on reserves were three times more likely than non-Aboriginal people to be hospitalized for a respiratory tract infection (1.5% versus 0.5%). Rates were lower in urban areas, but the rate for First Nations people living on reserves (1.0%) was still more than three times that for non-Aboriginal people (0.3%).

Regardless of whether they lived on or off reserves or in rural or urban areas, First Nations people were twice as likely as non-Aboriginal people to be hospitalized for asthma (0.2% versus 0.1%).

Respiratory tract infections

When age, sex and province/territory were taken into account, the odds of at least one respiratory tract infection hospitalization were over four times higher for First Nations people living on reserves (OR = 4.09; CI: 3.93 to 4.27), and more than twice as high among off-reserve First Nations people (OR = 2.34; CIs from 2.15 to 2.54), compared with non-Aboriginal people (Table 2). Successive adjustments for urban or rural residence, dwelling in need of major repair, crowding and household income reduced the odds of a respiratory tract infection hospitalization among First Nations people. Yet compared with non-Aboriginal people, significantly higher odds persisted: the odds of a respiratory tract infection hospitalization were nearly three times higher for First Nations people living on reserves (OR = 2.83; CI: 2.69 to 2.99), and about two times higher for those living off reserves (OR = 2.03; CI: 1.87 to 2.21).

Asthma

Patterns were similar for asthma hospitalizations. When only age, sex and province/territory were controlled, the odds that First Nations people (living on and off reserves) would be hospitalized because of asthma were more than twice the odds for non-Aboriginal people (Table 2). Adjustment for dwelling needing major repairs slightly reduced, but did not eliminate, differences in the odds. Unlike results for hospitalized respiratory tract infections, adjustment for crowding did not further affect the odds of asthma hospitalization. Further adjustment for household income quintile did reduce the odds, but even in the fully adjusted model, the odds of hospitalization for asthma were significantly higher among First Nations people living on reserves (OR = 1.33; CI: 1.16 to 1.51) or off reserves (OR = 1.57; CI: 1.33 to 1.86).

Discussion

Acute care hospital data linked to the 2006 Census were used to examine whether First Nations identity is associated with a greater likelihood of respiratory-related hospitalization, compared with non-Aboriginal people, and whether the difference persists after adjustment for housing conditions and other factors. Consistent with earlier studies,[9,14] individuals who identified as First Nations, particularly those living on reserves, were significantly more likely than non-Aboriginal people to report dwellings that needed major repair or crowded housing. Based on previously demonstrated links between respiratory problems and housing conditions or indoor air quality,[9-14] it was hypothesized that part of the disparity between First Nations and non-Aboriginal cohorts in respiratory hospitalization rates would be mediated by associations with housing characteristics. However, even after adjustment for dwelling in need of major repairs and crowding, differences in the odds of respiratory-related hospitalization remained.

What is already known on this subject?

- Respiratory diseases are among the leading causes of acute care hospitalization for First Nations people.
- Poor housing conditions have been linked to respiratory diseases.
- Associations between housing conditions and respiratory-related hospitalization must account for the possible confounding effects of income and place of residence.

What does this study add?

- This study used 2006 Census of the Population data linked to the hospital Discharge Abstract Database to examine associations between housing conditions and respiratory-related acute care hospitalizations among First Nations and non-Aboriginal people.
- The analysis adjusted for location of residence (on/off reserves, rural/urban) and household income.
- While housing conditions were associated with the likelihood of hospitalization for respiratory tract infections and asthma, household income could be more important.

It is unclear what is being measured by the two census-based housing characteristics. With more direct measures—for example, airborne contaminants or mould levels—the effects of specific exposures could be considered. Research has found that exposure to air contaminants affects respiratory health[10-13] and is associated with asthma, particularly in children.[12] For a 2011 study,[14] direct measures were taken in the homes of asthmatic children on one reserve to assess concentrations of settled dust mite allergens, endotoxins and fungal contaminants; reported levels of these pathogens were attributed to maintenance issues and moisture.

Adjustment for housing conditions reduced the differences between First Nations and non-Aboriginal people in respiratory-related hospitalizations, but adjustment for household income suggests a stronger effect of income. Associations between household income and both types of respiratory hospitalization in the final models were expected, given well-established links between economic status and health, and differences that generally exist between First Nations and non-Aboriginal people.[19,34] The present results suggest that additional research is needed. Associations between housing and health are complex; income adjustment could apply a broader perspective such as community well-being[35] or community economy. Economic prosperity, or lack of it, indicates the degree of support for and capacity of First Nations communities to address inadequate housing.[18]

Other factors that contribute to differences between First Nations and non-Aboriginal people in respiratory-related hospitalizations include access to and use of primary health care. First Nations people are reported to encounter greater barriers to receipt of primary care,[36] which may exacerbate health problems, and ultimately, result in the need for more acute levels of care. In addition, basic infrastructure deficiencies in First Nations communities, such as sewage and drinking water,[18] may have a negative affect on health, possibly increasing the likelihood of respiratory hospitalization.

Associations between housing and respiratory illness may be mediated through factors more directly related to respiratory problems such as smoking, nutrition and access to medication. However, information about these variables was not available in the linked data. The lack of smoking data was a major limitation, given the high prevalence of daily smoking among First Nations people.[37] In the current study, elevated rates of respiratory-related hospitalization among First Nations people may reflect differences in smoking behaviour and/or exposure to smoke in the home.[38,39] Children with mothers who smoke are reported to have increased rates of hospitalized asthma, and the presence of smokers in the household has been associated with greater likelihood of lower respiratory tract infections.[8] It would be worthwhile to build on previous work[40] and validate imputed measures of smoking for the 2006 Census data using other linkages.

The patterns that emerged in this analysis pertain only to acute care hospitalization, and are not generalizable to other types of hospitalization (for example, day surgery). Residents of collective dwellings were excluded from the derivation of crowded housing. Furthermore, no adjustment was made for the death of study cohort members. Because Aboriginal people have a greater risk of premature mortality than do non-Aboriginal people,[41,42] a downward bias may have influenced the estimates of hospitalization of First Nations people in the current study.

Conclusions

This study adds to evidence about factors associated with higher rates of hospitalization for selected respiratory problems among First Nations people. Although housing conditions were significantly related to rates of hospitalization for respiratory tract infections and asthma, additional factors must be considered. Results suggest that household income differences between First Nations and non-Aboriginal households could be more important. ■

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